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IS 11965 (1987): Round-headed cabbage - Storage in the open
[FAD 10: Processed Fruits and Vegetable Products]



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“Knowledge is such a treasure which cannot be stolen”

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*Indian Standard***ROUND-HEADED CABBAGE — STORAGE IN THE OPEN****National Foreword**

This Indian Standard, which is identical with ISO 6000-1981 'Round-headed cabbage — Storage in the open' issued by the International Organization for Standardization (ISO), was adopted by the Indian Standards Institution on the recommendation of the Fruits and Vegetables Sectional Committee and approval of the Agricultural and Food Products Division Council.

In the adopted standard, certain terminology and conventions are not identical with those used in the Indian Standard; attention is particularly drawn to the following:

- a) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use point (.) as decimal marker; and
- b) Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

This Indian Standard is also applicable to the areas where the temperature is sub-zero.

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0 Introduction

Cold storage of round-headed cabbage is practically unknown in a number of countries; on the other hand, storage in enclosed spaces, without artificial cooling, is better known, but most round-headed cabbage is commonly stored in clamps (temporary silos) constructed outdoors. This has resulted in the storage technique being largely dependent on local conditions, but, although the simple methods of storage are very well known, it is also necessary to describe them.

1 Scope and field of application

This International Standard lays down guidelines relating to the technique of storing round-headed cabbage (*Brassica oleracea* var. *capitata* Linnaeus sv. *alba* and *Brassica oleracea* var. *capitata* sv. *rubra*) outdoors, to allow a quality suitable for consumption or industrial use to be maintained.

2 Harvest and storage conditions

2.1 Cultivars

The storage techniques described apply equally to all cultivars of cabbage, the keeping of which is of economic interest. Differences due to the weather, soil conditions and other environmental factors in various regions and growing areas, are considerably greater than differences in cultivars.

However, cabbages of the late cultivars are generally more suitable for storage; so are cabbages grown in light or semi-compact soil.

2.2 Harvest

Cabbages intended for storage shall be ripe, headed and firm. A late harvest favours cracking during storage.

Cabbages harvested from humid soils are less suitable for storage, and irrigation should, therefore, be stopped at least 15 days before harvesting. They shall be harvested in dry weather, at a temperature below 10 °C. The optimum temperatures range from 0 to 5 °C. To avoid damage caused by freezing, cabbages shall not be harvested, handled or transported if the outdoor temperature is below 0 °C. It is recommended that cabbages harvested in wet weather be allowed to dry before storage.

The stem of the heads shall be cut between 1 and 2 cm below the level of the outer leaves; the cut shall be clean and smooth.

2.3 Quality

Cabbages intended for storage shall be whole, fresh in appearance, undamaged, sound and healthy, clean, and, in particular, free of soil and traces of water. Heads showing signs of attack by parasites or diseases or showing pronounced bruises or deterioration due to freezing shall be rejected.

Before storage, it is convenient to remove dead or damaged outer leaves from the heads.

Heads having a mass between 2 and 2,5 kg are most suitable for storage in the open air.

2.4 Putting into store

Cabbage of convenient maturity and suitable for storage shall be put into store as quickly as possible after harvesting. Prior to putting into store, however, the crop shall be dried in a ventilated place protected against frost. During drying, the outer leaves lose their brittle character and adhere tightly to the head. Dried cabbages are less sensitive to damage and disease. The duration of drying shall be 36 to 48 h when cabbages are not sufficiently dry during selection.

It is recommended that cabbages be stored at low temperatures.

2.5 Method of storage

The clamp (a cabbage pile of a roughly triangular cross-section) shall be situated in a location sheltered from water or atmospheric condensation, orientated, if possible, to take into account the prevailing winds. The depth, height, covering and ventilation of clamps vary according to country; different types of clamps may be combined :

- clamps with or without ventilation channels;
- clamps with or without covering;
- underground or soil surface clamps.

Underground clamps provide better storage conditions, notably more uniform temperatures and humidities. However, these types of clamp can be installed only in light and sandy soils and in dry soils. Soil surface clamps are constructed on

compact and heavy soils and on wet soils; in this case, the ground has to be level and clean.

The clamps may be of different sizes. For small clamps (width 1 to 1,2 m), ventilation channels are not usually provided. Such clamps are covered successively with thin layers of insulating materials above the cabbages and by thicker layers of material towards the outside. This allows the required conditions of ventilation to be obtained when the internal temperature drops. In these small clamps, the amount of heat evolved by the cabbages in respiration is lost through the covering layers of the clamps. Also, in clamps without ventilation, the carbon dioxide content increases due to respiration, which is advantageous for the stored cabbage.

Larger clamps (width 1,5 to 2,0 m) have to be ventilated in order to be quickly cooled and to expel the excessive heat evolved during respiration in the larger clamps after the cabbage is stored in the autumn. The ventilation channels have to be covered or uncovered according to the internal and external temperatures of the clamp.

The depths of underground clamps may be 20 to 60 cm. The ventilation channel, constructed from boards, shall be placed along the longitudinal axis of the clamp with its end protruding for a few centimetres.

Ventilation systems vary according to country. Ventilation of the clamps shall be assured by

- horizontal ventilation channels, of internal dimensions 20 to 30 cm and 40 to 50 cm longer at both ends than the base of the clamp;
- vertical ventilation channels, of internal dimensions 15 to 20 cm, of height 150 to 180 cm, and 40 to 50 cm higher than the clamp. Allowance should be made for channels every 2 m.

The recommended width of clamps is between 100 and 180 cm, and the corresponding height is from 70 to 140 cm (although other recommendations require a minimum width of 160 cm, with a permissible clamp height of up to 200 cm). The length of the clamp may be from 15 to 25 m.

The clamp base shall be covered with a layer of clean straw, 10 to 15 cm thick. For outdoor storage in clamps, provision should be made for 15 kg of straw per 100 kg of cabbage. Planks or open-work (lattice) crates may also be used as the foundation. The cabbages should be placed in rows with the cores pointing upwards. Each layer should contain cabbages of the same size.

The choice of the method of storage of cabbages in clamps depends upon local circumstances and conditions, but should guarantee that :

- in autumn, cabbages are cooled as quickly as possible to a temperature of 0 to + 1,0 °C;
- low and constant temperature and uniform humidity are maintained throughout the clamp for the full duration of storage;
- there is protection against the temperature dropping below 0 °C.

The methods and materials used for covering the clamps vary according to local conditions and depend on the ambient temperature and atmospheric humidity. The most important factor, however, is the rate of atmospheric precipitation. Thus the following may be used :

- a covering of earth (sand) in layers, directly over the cabbages;
- a single cover put directly on the clamp surface only;
- covering of the clamp with straw, cornstalk or other similar material, protected by a plastic film;
- a straw cover combined with an external covering of earth;
- covering with any other material locally available.

It is not necessary to provide a ventilation system if the stored cabbage has been pre-cooled and if there is only a thin covering. For this purpose, the heads of cabbage are stored in two or three layers, in a 300 cm wide clamp, sunk into the ground and covered with a layer of light sandy soil. The covering should allow the cabbage to cool as quickly as possible. When the temperature of the cabbage falls to 0 to + 1 °C, and the outdoor temperature is below freezing point, it is necessary to use a thicker covering, for example an earth layer, 10 to 20 cm thick, then over this, a straw layer 20 to 25 cm thick, and another earth layer, 10 to 15 cm thick. Such covering will be sufficient in the case of temperatures down to -20 °C. At lower temperatures, the thickness of the covering has to be increased.

The different storage methods and the various climatic conditions do not permit specification of the dimensions for clamps. The following data is given for information only.

| Dimensions of clamp | Ground area of clamp | Mass in one clamp | Ground area required for 10 t |
|---------------------|----------------------|-------------------|-------------------------------|
| cm | m ² | t | m ² |
| 150 × 120 × 2 500 | 37,5 | 7,4 | 300 |
| 200 × 170 × 2 500 | 50,0 | 14,0 | 175 |

The mass of 1 m³ of cabbage is about 350 kg, and, in the case of red cabbage, about 450 kg.

Clamps should be placed with the longitudinal sides at least 5 to 6 m apart without the cover; the ends of the clamps should be at least 3 m apart.

3 Optimum storage conditions

Values for temperature, relative humidity, and ventilation rates for clamps in the open cannot be exactly specified, as these parameters are difficult to control and depend on the predominant weather conditions. For this reason, this International Standard does not specify the conditions of storage but specifies the operations necessary for their determination.

3.1 Optimum temperature and its control

During storage, the temperature of the clamp should be checked three times a week during autumn, and at least twice a week in winter.

The optimum storage temperature is from 0 to + 1 °C. It is necessary to ensure that the temperature in the clamp does not fall below freezing point for extended periods.

It is equally dangerous if the temperature in the clamp exceeds 5 to 6 °C, and a temperature greater than 8 °C can provoke deterioration.

The temperature shall be measured by means of a thermometer at places 10 m apart along both sides of the clamp. At each place, the thermometer shall be introduced half way up the clamp side, perpendicularly to the layer of earth, and at a depth such that the end of the thermometer reaches the upper surfaces of the cabbages in the clamp. It shall be left from 15 to 20 min in the clamp before the temperature is measured.

The clamps shall be regularly checked during storage and all cracks and gaps shall be blocked up. If the outside temperature falls to freezing point, and if the clamp is not covered with snow, it is necessary to protect it by additional layers of earth. For this purpose, corn stalks, straw covered by tarpaulin etc., followed by another layer of earth, may be used.

During checking, a collapsed edge, a slumped side, or snow melting more quickly in certain places, is a sign of putrefaction of the cabbages.

Sporadic putrefaction of the outer leaves is not a hazard to the stored cabbages, but in the case of significant areas of putrefaction, the clamp must be demolished.

If the external air temperature remains at about 5 °C for 4 to 5 days, the earth layer shall be removed; above 10 °C, cabbages cannot be kept for more than a short time.

3.2 Relative humidity

The optimum relative humidity is from 85 to 90 % (0,85 to 0,90); it should be higher, rather than lower, than this value.

3.3 Duration of storage

Round-headed cabbage may be stored for a short duration up to December or January, or for a longer period up to March or April.

3.4 Covering of the clamps

The constructed clamp shall be loosely covered with a soft straw layer, 20 to 25 cm thick. This straw layer can be made thicker or covered with earth if the external temperature falls to - 1 to - 2 °C, or when the cabbage has properly cooled off.

Earth can also be used directly to cover the clamp — as straw, in contact with the cabbage, may cause mould to grow on the cabbage — by placing a layer of earth only a few centimetres thick over the cabbages. When the clamp has cooled and prior to the advent of a stronger frost, cover the clamp with straw, or any other insulating material, or with a second layer of earth.

If the external temperature continues to decrease and the temperature in the clamp approaches, or reaches freezing point, apply a further layer of earth to the clamp. This settled earth layer shall be of a thickness of about 10 cm. Frozen earth shall not be used. For this purpose, cover the soil adjacent to the clamp, to a width of 50 to 60 cm, with a layer of straw 5 to 10 cm thick prior to the advent of the first frost. Use the earth from under the straw layer for extra covering.

Covering clamps is also important in places where the autumn temperature does not approach freezing point. In this case, cabbage under the thin covering will cool off during the night and warm up less in the day-time.

3.5 Sorting and termination of storage

If the outside temperature exceeds + 5 °C for a long time, a careful check must be made for damage due to putrefaction. Extensive rot may necessitate the opening of the clamp, thus terminating storage. This is achieved by dismantling the clamp. The cabbages shall be removed from one end (face) of the clamp. They shall be removed by hand as the use of forks may impair the quality. The opened clamp shall be covered again if there is a risk of frost, but such covering shall be exclusively with straw.

The cabbages should be carefully sorted and the outer withered or rotten leaves should be removed; the stem should be cut shorter. Afterwards, the recovered cabbages may be marketed after vigorous grading to ensure a quality in accordance with local standards.

Annex A

List of round-headed cabbage varieties recommended for long periods of outdoor storage

| Producing country | Recommended varieties |
|-------------------|---|
| Hungary | Amager, Danish durable, and some regional varieties |
| Netherlands | Langedijker bewaarwitte, Langedijker bewaargele, Langedijker bewaar- rode |
| Poland | Langedijker, white and red Kamienna Glowa Zimowa z Mor |
| Romania | White : Amager, Braunschweig, de Buzău, Licurişca Red : Arges, L 403, Căp de negru |
| USSR | Amager, Zimovka, Beloruskaja, Podarok |

NOTE — The list of recommended varieties will be completed later when further information is available from other cabbage producing countries.

Annex B

Comments

The following comments refer to the role of the area of production and to unforeseen difficulties of storage.

B.1 Role of the area of production (Ecological and production method influences)

These influences, which manifest themselves in the case of round-headed cabbage put into cold store, are equally valid in the case of cabbage stored in clamps.

The following are especially unfavourable influences :

- premature or late harvest, having possibly run to seed;
- heads not sufficiently compact;
- soils over-treated with nitrogenous fertilizers, or moist and compact soils;
- harvest in the rainy season, wetness of the cabbage;
- lesions caused by frost, excessive loss of leaves, or stems cut too short.

B.2 Unforeseen difficulties in storage

Taking into account the range of diseases which can occur in storage, only a brief review is given.

B.2.1 Moisture or frost

Cabbage stored in a moist or frozen condition may become fusty. This can be prevented by appropriate treatment, for

example in the case of fustiness that has not yet spread extensively, by selection, moving and cooling, after which the sound heads can remain in storage. In more serious cases, and after the apparition of mould, the cabbages are no longer worth storing in clamps.

B.2.2 Freezing

The outer leaves of frozen cabbage are brittle, and wither and turn yellow after having been thawed. On cutting, the leaves appear vitreous and brown. After thawing, frozen cabbage must be used immediately as it cannot be further stored.

B.2.3 Grey mould (*Botrytis cinerea*)

This appears usually on moist, fusty, or damaged cabbages. The diseased leaves are covered by a layer of grey mould under which the leaves will brown and decay. The advent of grey mould can be prevented by careful handling during preparation and storage, and by protecting the cabbages from mechanical damage.

B.2.4 Black vein (*Pseudomonas campestris*)

The plant becomes infected with microbes in the area of production. The microbes propagate within the veins of the cabbage leaves, making the veins black. Often the disease is only visible after splitting the head. The diseased cabbage should not be used even for forage.

During selection, check for bacterial infection by boring and store only the cabbages showing no signs of infection.